KINEMATIC ANALYSIS OF INDIAN NATIONAL LEVEL SPRINTERS

A SYNOPSIS
SUBMITTED FOR THE AWARD OF THE DEGREE OF

Doctor of Philosophy

IN
PHYSICAL EDUCATION

By:

ROHIT SEHRAWAT
ADMISSION NO:

Under the Supervision of
Dr. Varender Singh Patial

Department of Physical Education
College of Education
IIMT UNIVERSITY
MEERUT (INDIA)
2023

CHAPTER 1 INTRODUCTION

Mechanics is the field of study relating to objects in motion, further kinesiology is a sub-theme of mechanics which means study relating to motion of biological beings mainly humans.

This is a very simple explanation of the two terms i.e., mechanics and biomechanics. If we dive deep into the space in which these notions operate, there is a much complex diversification and the field had developed step by step from time to time.

Various renowned scientists as well as astronomers have contributed to the gradual development of the concept of mechanics starting from Aristotelian Science explaining as earth as the centre of universe and proximate causes of motion to Copernicanism which was the complete opposite to and tried to remove the heart out from the Aristotelian Science by displacing earth from the centre of universe. Galileo Galilei explained the concept better while developing experimental physics and told earth is not the only proximate cause of movement. With this concept Galileo later explained motion of an object in a projectile and advanced mechanics. Everyone at that time explained the description of motion until Newton came and developed dynamics.

English physicist Sir Isaac Newton was the pioneer and one of the first modern scientist whose contribution lies unparalleled in the field of dynamics and study of motion as in 1686 he developed the universal theory of gravitation and introduced the concept of gravitation with the infamous apple tree incident and later in 1687 deduced laws of motion which revolutionized science which formed the base for millions of theories and experiments in the related field of study. In his book ‘Philosophiae Naturalis Principia Mathematica’ i.e., Mathematical Principles of Natural Philosophy, Sir Isaac Newton proposed three laws of motion that described and explained relationship of an object in motion and forces acting upon it.

Mechanics - "Mechanics is the branch of physics concerned with the effect of forces on the motion of bodies. It was the first branch of physics that was applied successfully to living systems, primarily to understanding the principles governing the movement of animals" (Davidovits, 1975)

Thus, at a broader level classical mechanics is classified into three distinct groups have different meaning and functionalities. These are: -

1. Statics: - deals with force acting on a body at a stable state of equilibrium or at rest.

2. Kinetics: - deals with the prediction of occurrence of a particular motion at a given situation.

3. Kinematics: - deals with the description of all possible outcomes of motion of a body or system of bodies.

Humans are complex beings and studying such a complex phenomenon that can differ from and within individuals taking all the other infinite external factors out of the account at a single hand is merely made possible with the induction of biomechanics into the field of mechanics and kinesiology. Biomechanics had made it possible to understand complex human movements as well as movement patterns in which human beings operate at various situations that trigger that movement. It is due to mere and very important fact that studying the musculoskeletal as well as neuromuscular movements are taken into consideration in biomechanics.

OBJECTIVES OF STUDY

- To find if the kinematic variables have significant relationship among themselves in the sprinters.
- Kinematic variable which produces a high involvement and has a contributing factor in the performance of the sprinters.

DELIMITATIONS

- For this study National athletes will be chosen.
- Further it will be delimited to the male athletes only.
- Only 10 sprinters will be selected for this study.
- Placement of foot during first four steps will only be studied for the study.
- Performance of the 20m sprinter will be noted.

Following variables are selected:

Linear kinematic:

- COM - center of mass

- H- Height of COM
- VX- Horizontal velocity
- VY-Vertical velocity

Angular kinematic:

- Joint at Ankle
- Joint at knee
- Joint at hip
- Joint at elbow
- Joint at wrist

Key positions:

- PFDFFS – Placement of foot during first four step
- SP – Stride Phase
- MKF- maximum knee flexion

LIMITATIONS

- Training of athletes which held at previous session for the study will not be part of this research work
- Diet, habits, mood, lifestyle, and other factors like sleep will be kept as limitation for this research.

HYPOTHESIS

Various renowned players and highly educated academicians were consulted and going through various research articles the researcher developed an understanding and hypotheses were formed.

- It is assumed that the selected kinematic variables will be significant contributor of Sprinters.
- It is assumed that angular variables will be significant contributor in sprinters block start.

DEFINITION AND EXPLAINATION OF TERMS

Biomechanics: - "Biomechanics is the science concerned with the internal and external forces acting on the human body and the effects produced by these forces. Biomechanics is the application of mechanical principles to living organisms."

Kinematics: - "Kinematics is the branch of biomechanics about the study of movement with reference to the amount of time taken to carry out the activity"

Linear Kinematics: - "Linear kinematics as such deals with the linear motion without taking into account the cause of the motion."

Angular kinematics: - "Angular kinematics deals with the rotation or the angular motion however; it does not study the cause of angular motion."

Centre of mass: - "The point at which all the body's mass seems to be concentrated. It is the balance point of the body."An exact point of the subject where the gravity's of the mass lie.

- Drive Phase
- Lift Phase
- Stride Phase

CHAPTER 2 REVIEW OF RELAED LITERATURE

For the purpose of this study various sources from internet and books were consulted, various research paper and studies conducted were taken into consideration,this reviewed literature is cited below.

Sayed Mohammad Ayub et. al. (2020) stated in this research the basics of the sprint start were analysed where the kinematic parameters which played a crucial role in the contribution to the peak performance and those which affect the kinematic parameters. for this purpose of the study the evaluation and investigation were performed on the male players and that too specifically national sprinters. the average age of the selected 10 national level sprinter came out to be 24.8 yrs. and their average height calculated was 5.1 feet and weight average was 72 kg. various parameters of body were considered where around 24 variables were taken into consideration and for each athlete 10 trials were recorded in the camera which had specifications as follows FDR-AX700 4K. as there were numerous variables in the study so it revealed that the model which was selected for the study was highly significant.

Rudrapal Yadav et.al (2017) the study conducted in Indian sub-continent ask the question that when the selectedkinematic variables are been investigated for the block start in sprinting races with the 30m sprintingperformance. For the purpose of the study inter-university or national level of male total 8 sample size were selected from different organizations loke sub-SAIcentre, Lucknow and from B.H.U, Varanasi. the range of the age is between 17 to 30 yrs. The study revealed that no such significant relation was found in the linear kinematic variables with the sprinting performance.

M Pon Pandi et.al (2018), from the permission of State sports council 3 national level of athletes were analysed from the state of Kerela where the kinematic variables at the start of block, the data of only 100m sprinters was investigated. for the purpose of this study the athletes gave 3 trials on the blocks where the biomechanical variables were taken into consideration the age of athletes was 18,22,28 yrs. A survey design was prepared for the three subjects. for the collection of data camera was used which was kept at 5m distance perpendicular to the block and subject. software used afterwards was KINOVEA motion analysis software for the data processing. various kinematic which were taken into consideration are hip peak angle, hip peak time, knee peak angle, ankle peak angles.

George Vagenas et.al (1998) for this study a sample size of 15 athletes was filmed where 20m sprint set mark for which the timings were recorded. the technique used for block

placement was the usual technique of hand-block spacing. for the purpose of data collection and to determine the dynamic strength of leg force platform was used. even for the purpose of knowing the dominant leg and to determine the lateral dominance, questionnaire method was implied. the results revealed that when the dominant foot placement was in the front then the faster sprinting timing were received. This study was found to be more reliablethan previous researches because of the empirical methods used were unreliable.so it was revealed from the study that the foot placement of dominant leg was crucial factor in improving performance.

Mann, R et.al (1984), examined During the 1982 and 1983 outdoors athletics seasons, Olympic level men (n > 15) and women (n > 20) sprinters (100m-400m) were recorded competing in up to five top-level competitions. The participants were subsequently biomechanically assessed. The goal of this initiative, which was called the Elite Athlete Project, was to provide players immediate feedback on their abilities, restrictions, and potential areas for performance development.

West, D. R. (1994). The target of the research was to see if there were any kinematic changes between sprinting with and without the speed chute. Eight West Michigan University track and field athletes were filmed performing two trials with and without the speed chute at 100 frames per second. To assess the effects of sprinting with or without the speed chute, three ANOVAs and descriptive statistics were carried out. Descriptive statistics gave information regarding many dependent variables. Although statistically significant differences (R.05) appeared between running without and with the use of the speed chute, those differences may not be practical for trainers to use to assess sprinting technique because they would be difficult to detect with the naked eye. As a result, the speed chute may be an appropriate choice.

Čoh, M et.al (2001), The objective of this research was to identify the basic morphologic and biomechanical features common to elite sprinters. The study contained 24 sprinters with 100-meter speeds records ranged from 10.21 to 11.19 secs. The sprinters' morphologic characteristics were evaluated using a test battery of 17 variables developed to comply with the International Biologic Programme (IBP) methodology. ERGO TESTER – Bosco carpet technology was used where the two parameters were taken into consideration i.e., low 20 m start and flying start that too 20m. rest all the flight phases, the different stride frequency and contact time was determined too. The duration parameters were measured with an infrared photocell system (BROWER Timing System). The t-test revealed no differences

between elite sprinters. But there was significant difference in the maximum velocity and starting acceleration of sprinters.

Simone Ciacci et.al (2017), examined male and female sprinters' initial biomechanics have been reported to differ. The objective of this research was to determine if kinematic deviations between males and females are due to a gender effect or to the sprinters' absolute performance level, determined by the 100-m time. A total of 20 sprinters (10 men and 10 women) were assessed, including world-class and elite competitors. The initial two steps have been studied starting from the "set" position. When the impact of the level of performance had been considered, linear regression analysis showed a few significant differences between sexes: males had a shorter pushing phase duration, higher horizontal speed at block clearance, and shorter contact periods of the first two steps. In contrast, most of the affected by the performance level. the fast sprinters had the centre of mass closer to the ground. there is partial difference in starting kinematic analysis between males and females, hence the new finding can be generalized to both genders.

CHAPTER 3 METHODOLOGY

PROCEDURE

The approach in this chapter will include the selection of variables, collection of the data, criterion measures, filming protocols and statistical technique will be applied.

SELECTION OF SUBJECTS

For the purpose of the study, 10 National level male athletes were selected from Jawaharlal Nehru Stadium, New Delhi. The participants were from different events of the athletics track and field event i.e., 100m, 200m, 400m. Purposive Sampling method was used for choosing highly skilled athletes. It was considered that they posses' good level of start technique due to their previous performance. Since the athletes were trained for a considerable time period, they were familiar with the start technique in the athletics

SELECTION OF VARIABLES

On the theories of literature, professional's opinion, amenities and apparatus availability and numerous kinematic variables might be decided on.

Linear kinematic:

- Height of COM at 1st step
- Height of COM at 2nd step
- Height of COM at 3rd step
- Height of COM at 4th step

Horizontal distance of first step, second step, third step and fourth step.

Angular kinematic:

- Joint at Ankle
- Joint at knee
- Joint at hip
- Joint at elbow
- Joint at wrist

PROCEDURE FOR COLLECTION OF DATA

The technique of the subject's selection, filming protocol and equipment obtained were described as under:

Equipment

Reference height roller, standard starting block, measuring tape, standard running track.

Filming Protocol

For the biomechanical analysis of block start videography was employed. Nikon D5600 camera was used with a frequency of 120 frames per second was placed at sagittal plane. Four steps were taken into consideration for the start. With the help of Kinovea software various kinematic variables were analysed for the block start.

Procedure for reference height

To determine the height of the reference researcher used the measuring tape and the height is used for the purpose of kinovea software.

Procedure for Measuring Selected Angular Kinematics

The specified kinematic variables such as, right wrist joint, the correct knee joint, right hip joint, right elbow joint, angles at right ankle joint, and horizontal distance of the initial step were acquired by measuring with the aid of Kinovea program.

Kinovea Software (Version -0.8.25)

Free video evaluation software called Kinovea was implemented. Players and trainers utilized the Kinovea program to perfect their methods. With the help of Kinovea, it could measure the length, speed, height, angle of various parts, centre of gravity, etc. on a specific movie. We were able to visually navigate the video collection using the integrated file explorer. Due to Kinovea's ability to operate practically any file natively, the software enables you to precisely monitor a single activity in the clip and analyses the motion piece and piece in slow motion. The function of Kinovea called "observation" involves closely examining movements on a movie frame by frame while doing it in slow motion. The videos had been synchronized in order to compare them concurrently. Analysis was accomplished by adding arrows.

REFERENCES:

1. Doscher W. The Art of Sprinting: Techniques for Speed and Performance. McFarland& Company Inc. Publisher. North Carolina. USA; 151-153. 2009.
2. Faccioni A. Kinematics data. 2009. Available at: www. adrian.sport.com; accessed on22.11.2012.
3. Ferro A, Rivera A, Parola I. Biomechanical analysis of the 7th IAAF WorldChampionships in Athletics –Seville 1999.New Studies in Athletics, 2001; (1,2): 25-60.
4. Gajer B, Thepaut-Mathieu C, Lehenaff D. Evolution of stride and amplitude duringcourse of the 100 m event in athletics. New Studies in Athletics, 1999; 3, 43–50.
5. Harland M, Steele J. Biomechanics of the Sprint Start. Sports Med, 1997; 23 (1): 11-20.
6. Hunter JP, Marshall RN, McNair PJ. Interaction of step length and step rate duringsprint running. Med SciSport Exer, 2004; 36: 261-271.
7. Giatsis, G, Kollias, I, Panoutsakopoulos, V, and Papaiakovou, Biomechanicaldifferences in elite beach-volleyball players in vertical squat jump on rigid and sandsurface. Sports Biomech 3: 145–158,2004.
8. Guissard, N, Duchateau, J, and Hainaut, K. EMG and mechanical changes duringsprint starts at different front block obliquities. Med Sci Sports Exerc 24: 1257–1263, 1992.
9. Hakkinen, K and Komi, PV. Training-induced changes in neuromuscular performanceunder voluntary and reflex conditions. Eur J Appl PhysiolOccupPhysiol 55: 147–155, 1986.
10. Harland, MJ and Steele, JR. Biomechanics of the sprint start. Sports Med 23: 11–20,1997.
11. Korchemny, R. A new concept for sprint start and acceleration training. New StudAthletics 7: 65–72, 1992.
12. Kraan, GA, van Veen, J, Snijders, CJ, and Storm, J. Starting from standing; why stepbackwards? J Biomech 34: 211–215, 2001.

13. Čoh M, Peharec S, Bacic P. The sprint start: biomechanical analysis of kinematic,dynamic and electromyographic parameters. New Studies in Athletics. 007;22(3):29–38. http://www.iaaf.org/development/ new-studies-in-athletics
14. Čoh M, Tomazin K. Kinematic analysis of the sprint start and acceleration from theblocks. New Studies in Athletics.2006;21(3):23–30.
15. Čoh M, Tomazin K, Stuhec S. The biomechanical model of the sprint starts and blockacceleration. Facta Universitatis: Physical Education and Sport. 2006;4 (2):103–114.
16. Fortier S, Basset FA, Mbourou GA, Favérial J, Teasdale N. Starting block performancein sprinters: a statistical method for identifying discriminative parameters of theperformance and an analysis of the effect of providing feedback over a 6-week period.J Sports Sci Med. 2005;4(2):134–143. PubMed